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The potential of index-based weather insurance to mitigate credit risk in agricultural microfinance

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Structure

- Motivation and hypotheses
- Data and methods
- Results
- Conclusions

Motivation and objectives

Motivation I

- Credit access is an important pre-requisite for economic development
- Succes of most microfinance institutions (MFI) in developing countries is limited to urban areas
- Outreach to rural areas still low
- Credit access for small-scale farmers in developing countries is strongly rationed (Beck et al. 2006; Diagne et al., 2000; Foltz, 2004; Petrick, 2004; Simtowe et al. 2008; Weber and Mußhoff, 2012)
- Weather risk might be a reason for the reluctance of MFIs to expand into rural areas
- Insuring weather induced credit risk of MFIs might help to sustain or even expand their agricultural lending activities (Miranda & Gonzales-Vega, 2011)

Motivation II

- Index-based weather insurance as an alternative to traditional, i.e., indemnity based insurance products for developing countries
- Limitations of index-based weather insurance for developing countries: few weather stations with reliable data and small plot size leads to high basis risk
- Instead of looking at the individual farm level, offering insurance on intermediary level could overcome these obstacles
- African Union initiated the African Risk Capacity (ARC), an index-based drought insurance scheme on country level

Hypotheses

- H1: Weather events increase credit risk for MFIs
- H2: Index-based weather has the potential to mitigate credit risk in agricultural microfinance

Data and methods

Data

- Data for microloans disbursed by „Accès Banque Madagascar“ (ABM)
- Regulated, commercial MFI with the focus on micro, small and medium-sized enterprises (SME loans, microloans, agricultural loans, warehous-receipts, deposits)
- Data set of 2007 – 2012, 16 branches in a radius of 200 km around the capital Antananarivo (central highlands)
- 3,534 loan disbursements of small-scale farmers in this period
- Weather data for three weather stations (Antananarivo, Ivato, Antsirabé) provided by the German Metereological Service
- Each branch is matched to the closest weather station

Methods – Specification of a weather index

- Looking for a weather event bearing a high production risk from an agricultural point of view (in rice production)
- Correlation analysis between credit risk and weather events:

  → too much precipiation in the harvesting period in march (Minten and Barrett, 2008)
- Cumulation index:

$$I_t = \sum_{d=1}^{x} R_d$$

- I_t = Precipitation sum inherent in a cumulation period x of a year t
- x = cumulation period march
- t = year
- R = precipitation
- d = day

Methods – Definition of credit risk

- Credit risk (after Basel II): default > 90 days (Portfolio at Risk, PAR 90)
- Considering monthly installments, short credit periods (80% less than one year) an intensive MFI-client-relationsship, PAR (90) is not so relevant in microfinance
- For MFIs (such as the ABM), microfinance is the main business
- Installments paid not in time endanger the banks liquidity
- Standard indicator in microfinance: PAR (1) and PAR (30)
- Leading to three risk categories: (1) loan repaid on time, (2) loan repaid with at least one installment delayed by one day, and (3) loans repaid with at least one installment delayed by 30 days

Methods/Data - Descriptive statistics

Depended Variable	Unit	Mean	SD	MIN	MAX
PAR-0	1/0[a)]	0.33	-	-	-
PAR-1	1/0[a)]	0.55	-	-	-
PAR-30	1/0[a)]	0.12	-	-	-
Independent Variable	**Unit**	**Mean**	**SD**	**MIN**	**MAX**
Accumulated March Precipitation in Antanana-rivo (Ivato)	Millimeters	379.46	168.24	72.50	610.12
Accumulated March Precipitation in Maha-noro	Millimeters	269.33	175.55	166.76	490.32
Accumulated March Precipitation in Tama-tave	Millimeters	257.50	152.63	146.76	464.32
Credit Volume	Ths.MGA[b)]/month	1,188.52	1,509.63	100.00	20,000.00
Credit Collateral	1/0 [a)]	0.87	-	-	-
Grace Period	1/0 [a)]	0.36	-	-	-
Repeat Client	1/0 [a)]	0.30	-	-	-
Household Income	Ths.MGA[b)]/month	1,757.66	2,503.90	59.17	45,052.80
Age	years	40.55	9.79	20.00	77.00
Female	1/0 [a)]	0.46	-	-	-
Family Members	number	5.05	1.90	1	17

a) Dummy variable: 1= yes, 0 = no. Mean values for dummy variables (1/0) indicate ratios.
b) Ths.MGA = Thousand Madagascar Ariary.

Methods – Estimation of credit risk

- Sequential Logit-model with three ordered categories:

$$\log \frac{P\,(Y_i = r | Y_i \geq r, x_i)}{1 - P\,(Y_i = r | Y_i \geq r, x_i)} = \beta_{01} + \boldsymbol{x'_i \beta}.$$

- *with* $\boldsymbol{x'_i \beta} = \beta_0 + \beta_1 \cdot I_t + \boldsymbol{\beta_2} \cdot \boldsymbol{c_{i,t}} + \boldsymbol{\beta_3} \cdot \boldsymbol{s_{i,t}} + \boldsymbol{\beta_4} \cdot \boldsymbol{j_t} + \boldsymbol{\beta_5} \cdot \boldsymbol{b_i} + \boldsymbol{\beta_6} \cdot \boldsymbol{w_i} + v$

- I_t = *accumulated amount of precipitation in March*
- c_t = vector of credit features
- $s_{i,t}$ = vector for the socio-demographic features of the clients
- j_t = vector of a dummy-variable for the year t, where the credit was disbursed
- b_i = vector of a dummy-variable for the 16 different ABM-branches
- w_i = vector of a dummy-variable for the 3 different weather stations

Results

Estimation results I

Variable [a]	Unit	Coefficient [b]	Std. Error	z-value	Relative marginal effect
(PAR-1 + PAR-30) versus PAR-0					
March Precipitation	Millimeters	1.36E-02***	2.53E-04	8.56	1.37 %
March Precipitation square	Millimeters	-1.41E-05***	-4.03E-06	-3.51	-0.01 %
Credit Volume	Ths.MGA [c]	0.18E-05	1.32E-04	- 0.14	0.02 %
Credit Volume square		3.47E-09	1.30E-08	0.27	0.01 %
Credit Collateral	1/0 [d]	- 0.65 ***	- 0.14	-4.52	-47.79 %
Grace Period	1/0 [d]	0.61**	0.25	2.43	84.04 %
Repeat Client	1/0 [d]	0.52 ***	0.09	5.22	68.20 %
Household Income	Ths.MGA/month	6.92E-04**	2.45E-04	2.45	0.07 %
Household Income square		- 6.73E-08***	- 2.59E-08	-2.60	-0.01 %
Age	years	0.03	0.03	1.02	3.05 %
Age square		-5.01E-04	3.59E-04	-1.39	-0.05 %
Female	1/0 [d]	0.16*	0.09	1.82	17.35 %
Family Members	number	-0.09	0.09	-1.02	-8.61 %
Number of Observations		3,534			
Likelihood-Ratio-Test $\chi^2(58)$		469 (p-Wert < 0.001)			

a) To correct our results from the influence of those variables, we checked the influences of the year, of the branch of lending, and of the weather station, where the March precipitation was measured. The results are not shown in table 2.
b) ***,**, and * describe a significant level of 99 %, 95 % or 90 %.
c) Ths.MGA = Thousand Madagascar Ariary.
d) Dummy variable: 1= yes, 0 = no.

Estimation results II

Variable [a]	Unit	Coefficient [b]	Std. Error	z-value	Relative marginal effect
PAR-30 versus PAR-1					
March Precipitation	Millimeters	2.19E-02*	1.16E-02	1.89	0.21 %
March Precipitation square	Millimeters	-2.36E-05*	1,35E-05	- 1.74	- 0.01 %
Credit Volume	Ths.MGA	1.20E-03**	5.26E-04	2.28	0.12 %
Credit Volume square		1.45E-07**	7.28E-08	1.99	0.01 %
Credit Collateral	1/0 [d]	- 2.07***	0.37	- 5.63	-67.38 %
Grace Period	1/0 [d]	13.49	1030.09	0.01	76.03 %
Repeat Client	1/0 [d]	0.61*	0.37	1.91	84.04 %
Household Income	Ths.MGA/month	7.21E-05	9.83E-05	0.73	0.01 %
Household Income square		2.201E-10	2.51E-09	0.09	0.01 %
Age	years	0.12	0.14	0.84	12.75 %
Age square		-1.51E-03	1.61E-03	- 0.94	- 0.15 %
Female	1/0 [d]	0.58*	0.33	1.75	78.60 %
Family Members	number	-0.15	0.30	- 0.51	-13.93 %
Number of Observations		3,534			
Likelihood-Ratio-Test $\chi^2(58)$		469 (p-Wert < 0.001)			

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Conclusions

Conclusions

- Acceptance of H1: Weather events increase credit risk for MFIs
- Marginal effects for the first transition with 1.37%/mm relatively large and less pronounced for the second transition (0.21%/mm)
- Acceptance of H2: Index-based weather insurance has the potential to mitigate credit risk in agricultural microfinance
- Credit risk can be expressed as a function of the precipitation sum of march
- BUT: Is weather risk what matters for credit rationing?

  Bearing the risk vs. transferring it?

  Wind might even be more relevant?

  Will insurance increase or reduce interest rates?

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Thanks for listening!

Literature

- Beck, T., A. Demirgüc-Kunt, L. Laevenand and V. Maksimovic (2006). The determinants of financ-ing obstacles. *Journal of International Money and Finance* 25: 932–952.
- Diagne, A., M. Zeller, and M. Sharma (2000). Empirical measurements of households' access to credit and credit constraints in developing countries: methodological issues and evidence". FCND Discussion Paper 90. International Food Policy Research Institute, Washington.
- Foltz, J.D. (2004). Credit market access and profitability in Tunisian agriculture. *Agricultural Economics* 30: 229–240.
- Minten, B., & Barrett C.B. (2008). Agricultural technology, productivity, and poverty in Madagascar. *World Development 36*(5), 797–822.
- Miranda, M.J. and C. Gonzalez-Vega (2011). Systemic risk, index insurance, and optimal management of agricultural loan portfolios in developing countries. *American Journal of Agricultural Economics* 93(2): 399–406.
- Petrick, M. (2004). A microeconomic analysis of credit rationing in the polish farm sector. *European Review of Agricultural Economics* 31: 77–101.
- Simtowe, F., A. Diagne, and M. Zeller (2008). "Who is credit constrained? Evidence from rural Malawi". *Agricultural Finance Review* 68: 255–272.
- Weber, R., and O. Musshoff (2012). Is agricultural microcredit really more risky? Evidence from Tanzania. *Agricultural Finance Review* 72(3): 416–435.